

'GAME THEORY': Another Technique to Supplement Pre-Project Risk Assessment or Post-Project Evaluation ¹

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INTRODUCTION

Russia's recent invasion of Ukraine in February 2022 sparked a renewed interest in **Game Theory**. Developed by **John von Neumann**,² and **Oskar Morgenstern**³ in the 1940s, **Game Theory is a technique for analyzing a situation whereby stakeholders interactively compete, and seek a dominant strategy**; i.e. a course of action or actions that -- *of all the possible strategies which could be used* -- would ultimately result in *their* best outcome, regardless of the opponent's tactics. **War gaming, of course, is quite complex** as it considers a *series* of moves and reactionary counter-moves, as well as feints to confuse the opponent in order to advance to one's objective. Various options are then scripted and practiced under actual or simulated conditions to test their effectiveness, validity, and ways to correct or refine their approach.

John Nash⁴ subsequently extended von Neumann & Morgenstern's work, adding the '**Nash equilibrium**' concept – a **sub-optimal 'saddle-point'**⁵ in an analytical '**zero-sum matrix**'⁶ situation where all benefit somewhat *considering the rational options of other stakeholders -- if they then agree to cooperate and satisfy*.⁷

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² John von Neumann (December 28, 1903 – February 8, 1957) a Hungarian - American mathematician and physicist, contributed to many fields: Set theory Functional analysis Quantum mechanics Ergodic theory Continuous geometry Economics Game theory Computer science Numerical analysis. (Wikipedia)

³ Oskar Morgenstern (January 24, 1902 – July 26, 1977) was a German-American economist. In collaboration with mathematician John von Neumann, he founded the mathematical field of game theory as applied to economics (see von Neumann–Morgenstern utility theorem). (Wikipedia)

⁴ John Forbes Nash Jr. (June 13, 1928 – May 23, 2015) was an American mathematician who made fundamental contributions to differential geometry, game theory, and the study of partial differential equations. Nash's work has provided insight into the factors that govern chance and decision-making inside complex systems found in everyday life. (Wikipedia)

⁵ The best option for all participants.

⁶ Zero-sum is a situation in game theory in which one person's gain is equivalent to another's loss, so the net change in wealth or benefit is zero. (www.investopedia.com/terms/z/zero-sumgame.asp).

⁷ An acceptable, but less-than optimum Outcome.

However, unabated behavior by self-interested stakeholders is inadvertently self-destructive, as it will inevitably create and perpetuate a **vicious cycle** detrimental to all. “**The Tragedy of the Commons**” essay in 1968 by ecologist **Garrett Hardin**⁸ is a classic example of Game Theory analysis leading to an undesirable Outcome. Hardin observed and analyzed population growth trends, then concluded that contemporary behavior of humans – *independently, but unrestrainedly competing for limited resources* -- would ultimately stress earth’s ecosystems beyond capacity, resulting in catastrophe for humanity. **A dismal prospect indeed!**

Unfortunately, not all stakeholders act rationally – *at least in the ‘Western’ concept of rationality* -- &/or abide by ‘Agreements’! **Some march to the beat of a different drummer**, and -- *fixating on their own objectives* -- are implacable. Rather than cooperating, compromising and satisficing, **rationality from their perspective is to persevere with their dominant strategy, despite the consequences!**⁹

Nevertheless, despite these limitations, Project Management planners and evaluators can also apply the Game Theory technique to help identify the root cause(s) of specific sector situations in need of improvement. Armed with potential behavioral insights of other stakeholders, Game Theory interaction analysis can help conceive project interventions to mitigate undesirable effects, &/or avert on-going, or potential, vicious cycles, to result in a more favorable sub-optimal, optimum or dominant outcome.

Although I had previously been a participant in several military war gaming exercises, my initial exposure to understanding Game Theory was in 1969, as a systematic policy-analysis Fellow of MIT’s Center for Advanced Engineering Study (CAES). However, a couple of years later -- *as an external evaluation team leader for an international development donor organization (IDO)* -- I had an opportunity to apply Game Theory to evaluate an on-going project under consideration for extension. The remainder of this article describes how that situation was analyzed, and some lessons learned therefrom, as an illustrative guide for others.

BACKGROUND

The **Rubber Improvement Project (RIP)** was an IDO project to improve tribal community village rubber plantations in a country¹⁰ during the late 1960’s & early 70’s. However, results were falling short of expectations, so a request had been received by the IDO to review, reassess, refinance and renew it.

⁸ Garrett James Hardin (April 21, 1915 – September 14, 2003) was an American ecologist who warned of the dangers of human overpopulation. (Wikipedia)

⁹ **Bottom line:** *You can’t negotiate in good faith with -- and trust -- some people! They won’t abide by agreements.*

¹⁰ Details regarding the location and organizations involved are withheld for privacy reasons. **What is important for this case example is application of the Game Theory approach to analyze the situation, and lessons learned**; rather than to criticize or castigate the country, organizations, officials, advisers, or community individuals involved.

Findings

From documentation and interviews at IDO Mission headquarters in the nation's capital, we learned that most plantations were established in the 1930's, but had been largely neglected for years. Current farming practices were considered inappropriate: i.e. little or no soil fertilizer use, inadequate tree nutrition, and poor tapping methods were used, damaging the trees. Consequently, rubber production was low, quality was deteriorating, and farmers -- and tappers -- incomes were declining.

A joint IDO/Country agricultural **subject matter expert (SME)** team had recently reviewed and **recommended multiple measures to rectify the situation.**

- **genetic research** to improve tree productivity and quality
- **pulling &/or pruning crowded tree stands**
- **replacing many mature and damaged trees**
- **replanting with younger ones** (*because output declined dramatically with age*)
- **proper, systematic spacing** (*because current close stands deprived each tree of adequate nutrition*)
- **chemical fertilization** to boost tree growth; plus
- **more extension training for farmers**, as well as
- **training/retraining rubber tree tappers**, and
- **equipping tappers** with new improved knives.

However, these measures were to be expected from SMEs. We evaluators were not Ag. Specialists. But even though the generic diagnostic “Problem/Solution/Results Tree” methodology had not yet been adopted for conducting IDO Project evaluations, I had a ‘*gut feeling*’ the Aggies might be barking up the wrong tree; addressing diverse **symptoms** rather than “**root causes**.”¹¹

No matter how many documents you read or briefings you receive at Mission headquarters, nothing beats “**ground truthing**,” i.e. first-hand visits to the job site to get a grasp of the situation. An IDO/HQ Agricultural Extension Advisor (AEA) accompanied us to the project site where project and local officials briefed us. They then took us to visit several plantations where we observed the environment, close-up; and interviewed some villagers, farmers and tappers.

¹¹ The very nature of the project was a ‘field day’ and ripe for puns!

During our visit we learned:

1. Plant Layout

Everything we'd read and heard previously referred to "**Plantations**" -- connoting expansive areas planted with rows of trees in a grid pattern, under single-entity management and supervision. However, that was quite a stretch. We discovered most 'plantations' were **small farm plots**: about a hectare, owned by individual families, plus several larger areas held "in common" by villages. Moreover, even the plots were jungle-like: carpeted with weeds, rotting trunks and assorted detritus, while trees were in all stages of growth -- *from "rogue" shoots, to mature, and ancient (i.e. no longer producing) plants* -- as well as being over-crowded, haphazardly spaced, and heavily scarred.

2. The Production Process

- Tappers cut a diagonal slash into the rubber tree bark then insert a tube -- *usually a piece of hollowed bamboo, or a metal tube* -- into the trunk at the lower end to catch the flow of rubber sap when it rises in the morning, and again as it falls at night.
- Rubber tapped from each tree, each day, is caught in a cup (usually a half scooped-out coconut shell, or can) affixed to the tree. The rubber quickly congeals into a semi-solid ball.
- After a few hours of tapping, the tapper collects all his rubber balls and places them along the roadside for sale to and pickup by another individual – a middleman.
- The middleman collects the rubber daily, using a spring weigh-scale to weigh, and pay spot cash to the tappers based on the weight of the balls.
- The middlemen then deliver and sell the balls to a rubber processor for further processing: melting, cleaning and forming into large rubber sheets.
- After cleaning, the processor sells the rubber sheets to wholesalers.

3. Further Findings

Discussing the dual issues of rubber production and income with local farmers, we learned many more factors compounding the situation:

- Land was originally owned by a tribal "Chief" who sold it. However, although land was abundant, only members of his predominant tribe were permitted to own land.
- The Chief placed unsold land in care of village headmen, and received periodic "tribute" from them.

- Owner families originally deforested the land and initially planted subsistence food crops. When their food crops proved insufficient for their family's needs -- or their area exceeded their physical capacity to farm it -- they gradually replaced their holdings with cash crops, of which the rubber tree was the predominant species.
- With each succeeding generation, families increased in size, and pressured to plant ever more rubber trees to sustain the family's income. However, inheritance practices also reduced the amount of land that could be passed on to surviving children; which in turn precipitated more migration and encroachment on other unoccupied lands; and the cycle was repeated.
- Concurrently there was an influx from other tribes resulting from civil conflicts in neighboring areas. Since these tribes could not own land themselves, they survived by share cropping with/for owner-farmers or as itinerant day laborer-tappers. However, with no investment or interest in sustaining the trees they tapped, individuals tapped as many trees as they could each day to maximize their income.
- In addition, each headman permitted village dwellers from all tribes to tap the trees "*in common*" on unsold land under his stewardship, in return for nominal daily payments.

Consequently – from the “users” point of view, no-one – neither land owners, community farmers, itinerant tappers, nor village headmen – had any incentive to nurture or uproot a rubber tree, no matter where it was or how poorly it produced. Aware that it would be years before a new rubber plant could become productive and income-generating, they all had a “do nothing” attitude, reasoning “*something*” was better than “nothing.” Thus, overuse and ever-increasing overexploitation of the aging plantation of unmanaged trees persisted by all parties, to their detriment and future livelihood.

4. The Processing & Sales Cycle

- When we returned to IDO Mission headquarters, we followed up on the processing and sales end of the cycle and got more “cause-effect” insight on what was further exacerbating the situation:
- The rubber processor also used a “weight per ball” method to pay the middleman; but as the quality of the rubber balls deteriorated, the price per kilo was reduced.
- After melting the rubber balls, and removing foreign particles (dirt, twigs, leaves, stones etc.), the processor cleaned, formed and solidified the rubber into crepe blocks and/or sheets of varying quality, for resale.
- Meanwhile middlemen lowered prices of purchase from the on-farm tappers.

- To offset the reduced income from their rubber, tappers then adulterated their balls with foreign object debris to increase their weight in order to maintain their income levels.

Systems Analysis

After mulling over our findings, I suddenly realized this rubber plantation production scenario was a **Nash-style zero-sum game**; another situation similar to the classic *Tragedy of the Commons*. It was a short-run “win-win” strategy for all, but ultimately a “lose-lose” **vicious cycle** for the entire rubber sector’s community of farmers & tappers, as follows:

- **Rubber trees are the major income resource** for owner-farmers and the community, while fees from villagers and itinerant tappers are a prime source of revenue for the village headman.
- Since villagers and itinerate tappers don’t own land or the trees, **every tapper’s immediate incentive is to extract as much rubber as they can** during their daily tapping activity to maximize their income, without worrying about the niceties of tree protection and maintenance.
- Short-sightedly, **the headmen view their Commons ‘plantations’ as inexhaustible resources**, and maximized their incomes by permitting as many tappers as possible each day.

In a Game Theory Matrix, the setup was as follows:

		The Village Community	
		Strategy: To Tap	Strategy: Not Tap
Individual Farmers & Tappers	Strategy: To Tap	+	-
	Strategy: Not Tap	-	-

In essence:

If **both** Individual Farm Tappers and Community Villagers Tap, they **both benefit**. [Green + +]

If only the Individual Tapper taps but the Community does not, the Individual Tapper benefits, and the Community loses. [+ -]

Likewise, if the Individual Tapper does not tap, but the Community does, the Individual Tapper loses, and the Community benefits. [- +]

If neither Tap, they **both lose**. [Red - -]

The “Saddle Point” [Green + +] is a “win-win” where both the Community and individual farmers (and itinerate tappers) maximize their situation. *However, while beneficial to both parties in the short run, indiscriminate tapping by both parties is at the expense of long-term sustainability. This process was a “vicious cycle” which would perpetuate itself unless and until a change in behavior intervenes to arrest and/or reverse the decline. This was the root cause of the project’s productivity problem situation! Eureka!*

Furthermore, Pricing by weight was a second “vicious cycle” vortex, and the root cause of quality deterioration!¹²

Summary Analysis & Conclusions

Thus, although the proposed solutions by the agricultural SME consultants to improve productivity and quality were intrinsically technically sound, given the prevailing land tenure situation and pricing structure, the technical agriculture sector approaches were all non-sequiturs! Problems of communal plantation ownership, lax guardianship by village headmen and itinerant tapping *would not be resolved*, and indeed *could not even be alleviated* by doubling down on agricultural production practices. *It simply was not feasible to uproot and replant ideal plantations* as envisaged by the research station specialists. Moreover, given the current disposition of landless tappers, *any extension activity to train and equip them with better tools would be futile*. The situation required political interventions beyond the IDO Project Manager’s power.

Recommendations

We recommended the IDO HQs Director disregard the Joint IDO/Country SME report, and instead **initiate IDO-to-Government-level discussions for Policy intervention to change raw rubber purchasing practices from purely by Weight, to a variable price scale based on Volume & Quality**. Although not a panacea, that should resolve the declining quality issue. But before the seemingly-intractable social property ownership issues were satisfactorily addressed, further external IDO Technical Ag. Assistance (TA) was moot.

¹² NOTE: ‘Cause and Effect’ diagrams – such as those developed and utilized by Jay Forrester (described in his ‘Industrial Dynamics,’ ‘Urban Dynamics’ and ‘World Dynamics’ books); ‘Limits to Growth’ by Dennis & Donella Meadows; and subsequently ‘Theory of Change’ by the United Nations Development Programme (UNDP) -- are also other very helpful techniques for modelling, programming and analyzing complex interactive situations.

Reaction & Results

Needless to say, the IDO Mission's Project personnel were less than enthusiastic about our report! They perceived us as amateur outsiders -- *not even technically qualified "Aggies"* -- who had ignored the recommendations of their own SME advisors in favor of a purely sociological viewpoint.

I never knew whether our recommendations were ever actually adopted. Unlike Audit findings, external evaluators have no mandatory enforcement powers, and usually get no feedback from the clients!

CONCLUSION

I found the Game Theory approach invaluable for this, and several subsequent evaluations; and offer **Eight Essential Guidelines** for other External Evaluators:

1. **Gather data from multiple sources** – historical records, previous reports, technical advisors and particularly feedback from target beneficiaries (end users/customers).
2. **Conduct on-site project visits & rapid reconnaissance** to obtain a “Reader’s Digest” appreciation of the situation.
3. **Listen to SMEs but don’t rely on their predilections for your recommendations.** SMEs are biased by their background, and Project SMEs are so close to the situation they are often so narrowly focused they can’t see the bigger picture -- in this case they couldn’t see the *‘Plantation’ for the Trees* -- a parody on the old *“Forest & Trees”* adage.
4. **Do your own process mapping and systems analysis**, then look for “*What’s in it for me*” (WIIFM), and “*Follow the Money*” of all stakeholders to identify their respective performance incentives.
5. **You don’t have to be a sector expert in order to analyze a socio-technical-economic process**, but you do need to understand -- and be able to apply -- basic logic and some quantitative analysis.
6. **Don’t expect appreciation for your efforts** – *especially not from project SME personnel you came to ‘help’*.
7. **Don’t expect Organization HQ management executives – who requested the evaluation -- to automatically accept and implement your recommendations.**
8. When you’ve done **Your job; Let it Go! Let it Go!**

About the Author



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Initially a US Civil Service Management Intern, then a management analyst & systems specialist with the US Defense Department, Ken subsequently had a career as a senior foreign service officer -- management & evaluation specialist, project manager, and in-house facilitator/trainer -- with the US Agency for International Development (USAID). Ken assisted host country governments in many countries to plan, monitor and evaluate projects in various technical sectors; working 'hands-on' with their officers as well as other USAID personnel, contractors and NGOs. Intermittently, he was also a team leader &/or team member to conduct project, program & and country-level portfolio analyses and evaluations.

Concurrently, Ken had an active dual career as Air Force ready-reservist in Asia (Japan, Korea, Vietnam, Thailand, Indonesia, Philippines) as well as the Washington D.C. area; was Chairman of a Congressional Services Academy Advisory Board (SAAB); and had additional duties as an Air Force Academy Liaison Officer. He retired as a 'bird' colonel.

After retirement from USAID, Ken was a project management consultant for ADB, the World Bank, UNDP and USAID.

He earned his DPA (Doctor of Public Administration) from the George Mason University (GMU) in Virginia, his MS from Massachusetts Institute of Technology (MIT Systems Analysis Fellow, Center for Advanced Engineering Study), and BA & MA degrees in Government & International Relations from the University of Connecticut (UCONN). A long-time member of the Project Management Institute (PMI) and IPMA-USA, Ken is a Certified Project Management Professional (PMP®) and a member of the PMI®-Honolulu and Philippines Chapters.

Ken's book -- **Project Management PRAXIS** (available from Amazon) -- includes many innovative project management tools & techniques; and describes a "**Toolkit**" of related templates available directly from him at kenfsmith@aol.com on proof of purchase of PRAXIS.

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